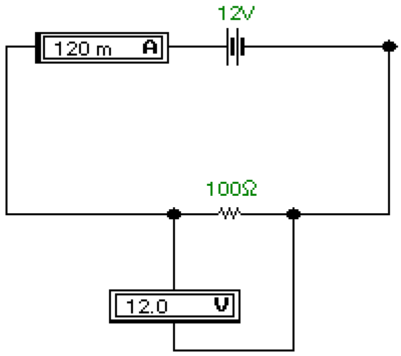
Ohm's Law and Resistive Circuits

Definitions: *Ampere* (A): a unit of current flow (coulomb/second).
Volt (V): a unit of electrical potential (joule/coulomb).
Ohm (Ω): a unit of resistance to the flow of electrical current (volt/amp).
Ohmic: a device that obeys Ohm's law

All circuits (except superconducting circuits) contain some resistance. Even if there are no resistors or other devices connected in a circuit, the connecting wires and power supply will have a small amount of resistance to current flow. In this section you will explore the relationship between voltage and current for three different types of resistive circuits: linear (ohmic), non-linear (non-ohmic), and a circuit containing a diode.

Consider a circuit containing a 12 volt power supply connected in series with a 100 ohm resistor such as that shown in Figure 1. An ammeter is connected in *series* with the resistor and a voltmeter is connected in *parallel* with the resistor. In an electrical circuit, test instruments have a small but discernible effect on the operation of the circuit. Understanding how these instruments affect a circuit is crucial to understanding how the entire circuit works.



The circuit in Figure 1 has an *applied voltage* of 12 volts. This means that the electrical potential of the left terminal of the power supply is 12V higher than the electrical potential of the right (generally this means that the high potential terminal is at 12V and the low potential terminal is at 0V). As current flows around the circuit counter clockwise in this case) the potential decreases each time the current passes through a resistor. Ignoring the small amount of resistance in the connecting wires, the potential drop across the resistor in this circuit equals the applied voltage. This would be the case regardless of the value of the resistor, i.e., the drop would be 12 volts if the resistor were 1 ohm or 10000000 ohms. This electrical energy is converted to heat by the resistor.

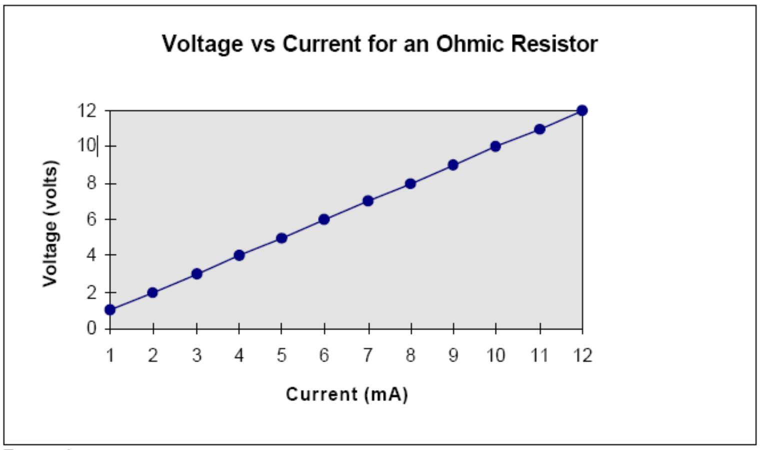
Unlike electrical potential, current is not "used up" as it flows through a resistor. The current in Figure 1 is the same whether it is measured before or after the resistor. The amount of current flow depends upon both the value of the resistor and the applied voltage and is governed by Ohm's Law: $V = IR$. In this example the current is: which is the same as 120×10^{-3} amperes or 120 mA.

$$V = IR$$

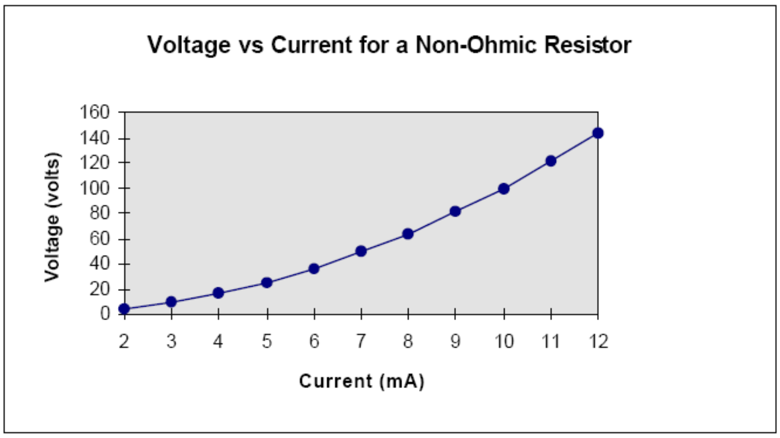
$$V/R = I$$

$$12/100 = I$$

Ohmic Resistors



Non – Ohmic resistors



A non-ohmic resistor has a value that depends upon the applied voltage and current. Non-ohmic resistors are also referred to as non-linear because a plot of voltage vs. current for such a resistor will not be a straight line

Diodes

Most resistors are oblivious to which direction the current is flowing or even whether the current is direct or alternating. A diode is a circuit element that allows current to flow freely only in one direction. Figure 6 shows a diode in its two possible configurations: forward and reverse bias. The circuit on the left contains a forward biased diode which acts like an extremely small resistor that does nothing to impede the flow of current. The circuit on the right contains a diode that has been inserted in the direction of reverse bias. In this direction the diode acts essentially as resistor of infinite value. It is important to note that all reverse biased diodes will allow current to flow if the applied voltage is large enough.